Intelligent Systems

Components – North America

Thread – Home Automation Done Simple, Secure, Scalable

NXP adds to the equation low-cost and quick

It doesn't matter if it's done from a startup or a corporation, as new smart devices for home automation are conceived, there are technical challenges that need to be addressed, preventing a quicker product market launch that could be the difference between success and failure.



Connectivity is the critical and central part of the technical design that needs to be solved. Not all technologies are suitable for smart home devices, certainly the most known and used are Wi-Fi® and Bluetooth®, however they are limited or only provide partial solution to the challenges that most commonly arise when developing these kind of devices, making it evident that a gap exists.

The Thread Group is an industry alliance that was originally formed by seven companies to address this exact challenge. Its current membership has now grown to over 220 companies.

Their solution—Thread—is a networking technology designed to support mass adoption of the IoT in the home and beyond. In order to create smart solutions for a wide variety of IoT applications, the right technologies for sensing, processing, and connecting are needed. A strong infrastructure will enable innovative products that can be brought to market quickly.

This article covers the fundamentals of Thread, like network architecture, commissioning & security, as well as product certification; at the end, it gives a glance at NXP's Thread Platform that as one of the seven group founding members, enables to engineer a complete end-to-end Thread system, adding to the equation for a faster product to market.

IoT Connectivity Landscape

Besides Wi-Fi® and Bluetooth®, the IEEE® 802.15.4 standard is another connectivity technology designed for low-rate wireless personal area networks. IEEE 802.15.4 implements the MAC and PHY layers of the OSI networking model, which are designed for low cost, low complexity, low power, and to support low data rate transmissions—all ideal attributes for control and monitoring applications.

IEEE 802.15.4 chipsets are highly reliable, having shipped hundreds of millions of units since the standard was first ratified. They serve as the hardware foundation for many mesh networking layers, including Thread, providing a robust, reliable solution for device-to-device communication.



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Thread protocol is IP-based, so every device in the network is directly addressable. Above the networking layer sits the application layer. There are numerous application layer options that can run on Thread, e.g. Nest Weave, HomeKit, AllJoyn, ZigBee®. The networking layer defines how devices connect and communicate while the application layer defines the user experience.

The Need for a New Wireless Standard

Despite existing networking standards used in the IoT space, many market segments and applications have unique needs. With advantages for connecting devices in the home rapidly developing (e.g., thermostats, lighting, door locks, safety and security, video cams, major appliances), Thread was created to accelerate growth of this market by providing a networking protocol to address all of the key market requirements:

- IP Addressable device-to-device/device-to-cloud direct communication
- Consumer friendly simple to add/remove from the network
- · Always secure secure method for joining network and encryption of data
- Robust, reliable mesh network scalable to an entire home/building
- Extremely low power able to run for years off a small battery



Thread supports many popular application layer protocols and platforms. A software upgrade can add Thread to currently-shipping 802.15.4 products.



Thread provides an IPv6-based mesh networking protocol to connect products to each other, to the Internet, and to the cloud. It uses 6LoWPAN header compression and fragmentation that enables IPv6 packets to be sent using the smaller PHY payload of the 802.15.4 protocol. It runs on existing silicon (802.15.4 radios), so products using the same radio technology only require a firmware upgrade for full compatibility.

Commissioning and security were the two most critical areas of focus during development. Products need to be easily added or removed from the network by consumers while completely preventing any sort of unauthorized network access.

In support of the robust projected growth of products for the connected home, a Thread network can scale to include over 250 devices. For connected products such as light bulbs and window sensors, the number of nodes can be large depending on the size of the building. For battery-operated products such as door locks, Thread's low-power operation enables years of battery life without compromising product performance.

Thread is an open and global protocol—any company who joins the Thread Group can implement it in its products. By utilizing existing proven and open standards, Thread enables faster time-to-market for manufactures that need to hit a fast approaching window.

Network Architecture

Devices in a Thread network can play different roles. A Thread router directs packets between devices on the network. In addition to these duties, a routing device may also have its own product data to send out as well. Among the Thread routers, one device is selected by the network to be the leader. This leader manages the network traffic to determine how many routers are needed for effective, reliable communication between all devices. End nodes can come with or without routing capabilities (which means the device may be promoted to serve as a router if the network determines better coverage is required).



Figure 2: Thread network architecture

A border router plays a different role, where the device translates packets between an 802.15.4-based Thread network and the cloud or Internet (typically using Wi-Fi or Ethernet). There can be more than one border router and it doesn't require a dedicated gateway. A border router can also provide direct Wi-Fi connectivity to phones, tablets, or other devices in the home network, allowing local control even when a connection to the Web or cloud is not available. If the border router malfunctions and stops working, the Thread network will continue to operate seamlessly.

Thread does not replace Wi-Fi or Bluetooth; it complements them. Thread provides a true mesh network that allows devices to communicate reliably to each other. Thread is neither a flood nor a repeating architecture. If one route fails, a new route can be established — keeping communication to a minimum while effectively getting data to the intended destination.

Thread's cloud connectivity provides the critical ability to control and monitor a home when the residents are away or to communicate directly to devices on the network with a phone or tablet, even when an Internet connection is not available.

Commissioning & Security

Devices join the network through a process called "commissioning." An end device with a GUI interface that's already part of the network may be used to commission new devices. Users can also add a device to the network by authorizing it via smartphone, tablet, or computer.

A Thread commissioning app provides a simple method for adding new products. The app uses either a QR code or a key code (labeled on the product itself) to create a temporary security session with the network. Network information and security credentials are shared and the commissioned device is now online. Messages sent within the network are always encrypted. Application layer security may also be included based on the specific product requirements.

The Thread specification is solely focused on the network layer and is application-layer agnostic. There are many feature-rich and proven application layers available today which can theoretically be designed to run seamlessly on Thread—including Nest Weave, AllJoyn, HomeKit and ZigBee. Similar to Wi-Fi or Ethernet, product manufacturers have the freedom to choose and integrate the application layer that best suits their specific needs.

Product Certification

In order to ensure interoperability at the networking layer, all Thread devices are required to be certified prior to using the Thread certified logo. The certification process validates commissioning, network functionality, interoperability, and operation within the network. This program supports components such as software stacks and modules as well as commercial products.

Sponsor and Contributor members have access to both a standard test harness and a sample commissioning app to aid in this process. All certifications are performed by a Thread-approved, third-party test lab.

NXP's Thread Platform

As one of the founding members of Thread Group, NXP has been and continues to be an active participant in defining the spec and developing an interoperable stack. NXP offers various platforms that provide all the necessary building blocks for Thread routers, border routers, and end devices—helping customers develop a complete, end-to-end Thread system.

NXP provides a single-chip solution for Thread end nodes and routers with the Kinetis W series MCUs. These devices include an ARM® Cortex[™]-M4 core with integrated 802.15.4 connectivity and enough embedded memory to run the Thread stack as well as application code.

For Thread systems that require more memory or a different feature set, NXP also has a standalone 802.15.4 radio (the MCR20) that can be paired with any of the hundreds of Kinetis Cortex-M-based MCUs. This architecture can be used to build Thread end nodes, routers, and border routers.

In a Thread network, there can be a single border router or multiple border routers that can be implemented in two different ways depending on the application and its overall requirements. The two types of border routers are 1) an MCU-based system running FreeRTOS and 2) an MPU-based system running Linux®. A Linux-based system adds capabilities such as data management and analytics, events processing, and cloud connectivity. With the scalable Kinetis MCU portfolio, the Kinetis K64 MCU with integrated Ethernet can be used as an RTOS-based border router. For the higher performance Linux border router, the i.MX 6UL applications processor based on the ARM Cortex[™]-A5 core is an ideal solution. For each of the NXP solutions, various development platform options are provided to enable quicker design.

The following table summarizes the NXP-certified Thread solutions:

Thread Role	NXP Solution	NXP Development Platform
Router, End Node	Kinetis KW2xD MCU	TWR-KW2x, FRDM-KW24, USB-KW24D512
End Node	Kinetis MCU + MCR20A Transceiver	TWR or FRDM for specific Kinetis device, FRDM-MCR20A
RTOS Border Router	Kinetis K64F MCU + MCR20A	FRDM-K64F, FRDM-MCR20A
	Transceiver	
Linux Border Router	i.MX 6UL Processor + Kinetis KW2xD	i.MX6UL EVK, USB-KW24D512 (USB dongle to add
	MCU	Thread)



Figure 3: NXP Freedom Development Platform

In addition to the hardware platform options, NXP also provides a complete software solution. The NXP implementation of the Thread spec includes all components needed in a Thread network and is one of the first certified stacks available. This Kinetis Thread software stack is optimized for low power, scalability, and robustness. It comes with pre-baked COAP-based applications to reliably transfer data inside and outside the Thread network. COAP is a software protocol that allows interactive communication over the Internet, targeting small low-power devices such as those in smart home environments.

Thread + NXP, Enabling the Smart Home and Beyond

As developers build-out the Internet of Things with new ideas and designs, Thread offers a low-power, wireless mesh networking protocol to easily connect their products—complementing existing network technologies while providing a simple, secure and scalable solution.

NXP, one of founding members of Thread, offers a comprehensive platform that provide all the necessary building blocks to make a complete end-to-end Thread system, independently of the complexity of the product envisioned.

Together, Thread and NXP can help bring any smart home device to market quicker, incrementing the possibilities of success.

For details on Thread Group membership and access to the standard, visit: http://www.threadgroup.org/

For details about NXP's Thread platform, visit: http://www.nxp.com/thread

Contact Us Today!

Call **1-800-833-3557** to speak with your local Arrow M2M business development manager, or email us at m2m@arrow.com for more information.



Arrow Electronics, Inc. Intelligent Systems 9201 E Dry Creek Rd. Englewood, CO 80112